

Morphological Differentiation of a Terrace due to the Dissection Pattern in the Case of Koriyama Basin, Fukushima Prefecture

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雑誌名	The science reports of the Tohoku University. 7th series, Geography
巻	17
号	1
ページ	5-18
発行年	1968-03
URL	http://hdl.handle.net/10097/44893

Morphological Differentiation of a Terrace due to the Dissection Pattern in the Case of Koriyama Basin, Fukushima Prefecture

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1. Problem setting and the method of the study

In these few years the writer has sought some aerial regularities in development of dissecting valleys in mountains and hills. Though he has not found a certain regularity deduced from present distribution of dissecting valleys, he recognizes that there are two types of valleys different in their transverse profiles, and that they are situated in different locations within a drainage basin to construct a drainage system conjugated each other. The two types are the V-shaped valley (*Kerbtal*, including *Sohlen-kerbtal*) and the shallow-concave valley (*Muldental*) (Louis 1960). The writer has called the latter "high-level valley" (Nakamura 1963, 1966a, 1967a) after its location in a drainage basin. In the hill-lands in Tohoku District, for examples, piedmont areas of the Abukuma and the Kitakami Mountains, of the Ōu backbone range, and in most parts of Neogene Tertiary regions, we can see that the hills are characterized by the coexistence of the valleys of these two types, in addition to flat leveled summits, high density of dissecting valleys and so on.

Now the writer pays attention to the terrace dissection because he has ascertained that a difference in dissecting valley types has not a little influence upon the process of terrace dissection in the meaning of morphological differentiation within a unit of landforms (Nakamura 1967b, c). In order to ascertain the effect of valley type difference and of its coexistence on terrace dissection, here the writer takes an example of upland in the Koriyama Basin, Fukushima Prefecture, to examine this subject by the following method.

At first the valley form of each tributary is sorted as either *Muldental* or *Kerbtal* (including *Sohlen-kerbtal*) by air photo interpretation in the scale of 1:20,000, and field observations, then drainage systems are mapped with different designation for each valley form. Finally some longitudinal and transverse profiles are picked up and some characteristics in valley form distribution are pointed out in schematic diagrams. Dissection pattern for a terrace that is the object of the study would be discussed based upon these distribution maps which are drawn with the aid of reading 1 meter intercontour maps of Koriyama City 1:3,000 in scale.

2. Observations on some features of terrace dissection

1) Summary of geology and morphology of the study area

In the last decade many studies on geology and morphology of the Koriyama Basin and its adjacent areas have been published (Koriyama Quaternary Research Group 1962, 1964, Wako 1963, Suzuki and Soma 1965, Suzuki, *et al.* 1967). The descriptions concerned with the present paper are as follows¹⁾.

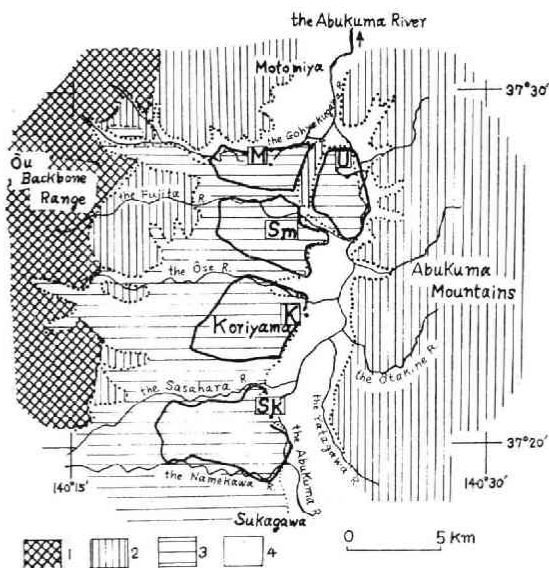


Fig. 1 Index map 1 mountains 2 hills 3 terraces 4 alluvial plains
M: Maedasawa U: Umesawa Sm: Shimoyashiki K: Koriyama Sk: Sasakawa

Geology: The Koriyama Formation, Pleistocene deposit correlated to Mindel/Riss~Riss Ice Age (Suzuki, *et al.* 1967), distributes widely in the basin. It consists of sand, gravel, mudstone in alternation with three sheets of peat beds, about 80 meters thick at Koriyama station at the maximum. The Otsuki fan deposits from which fossil-woods are found and dated as 25,400±900 years and 23,800±1,100 years B.P. (Koriyama Q.R.G. 1964), are composed of gravels, tuffaceous shale with peat layers, and cover the Koriyama Formation at the western part of the basin. Tertiary sedimentaries, green tuff, sandstone, etc., widely develop to the west, and pre-Tertiary rocks, granite, diorite, schist, etc., to the east over the Abukuma river.

1) There is also unpublished one (Narita 1962).

Morphology: According to T. Wako's description (1963) the surfaces in the basin are classified into five steps, from upper to lower, as 1) Kotanbara Surface, erosion surface cutting the Pliocene formation, 2) Koriyama Surface and Shobune Surface composed of Koriyama formation (Photo 1), 3) Otsuki Surface, the upper and the lower, covering the Koriyama surface in the upstream and cutting it in the downstream, 4) Mihota Surface, and 5) Lowest Terrace and the present flood plain. K. Suzuki, *et al.* (1953) subdivided most part of the Upper Otsuki Surface (by Wako) into Nishinouchi and Arayashiki Surfaces, and described them as erosion surfaces cutting the Koriyama formation, formed closely before the deposition of Otsuki fan deposits.



Photo 1 Undulation of terrace surface, western foot of the Abukuma Mountains

In the present paper, dissection features chiefly on the Koriyama, the upper Otsuki (or the Nishinouchi) surfaces are discussed. These terrace surfaces are divided here into following five sections by the five large tributaries joining orthogonally into the Abukuma river from the west with about 3 km in distance, and are partly by a small range of bedrock extending in N-S direction (Fig. 1).

2) The Macdasawa section (Fig. 2)

This section is an interfluvium between the Gohyakugawa²⁾ and the Fujita rivers, bordered to the east by the hill of pre-Tertiary bedrock, 320–280 meters high, separated from the next Umesawa section. The divide is shifted southward, so dissecting valleys develop running northward in the Gohyakugawa's basin. Streams of the five tributaries (Tm 1–5) have N-ENE direction and are 1.5–2 km in

2) The Gohyakugawa is sometimes called the Yokawa, as shown in the topographical map "Koriyama" 1:50,000 (Wako 1963)

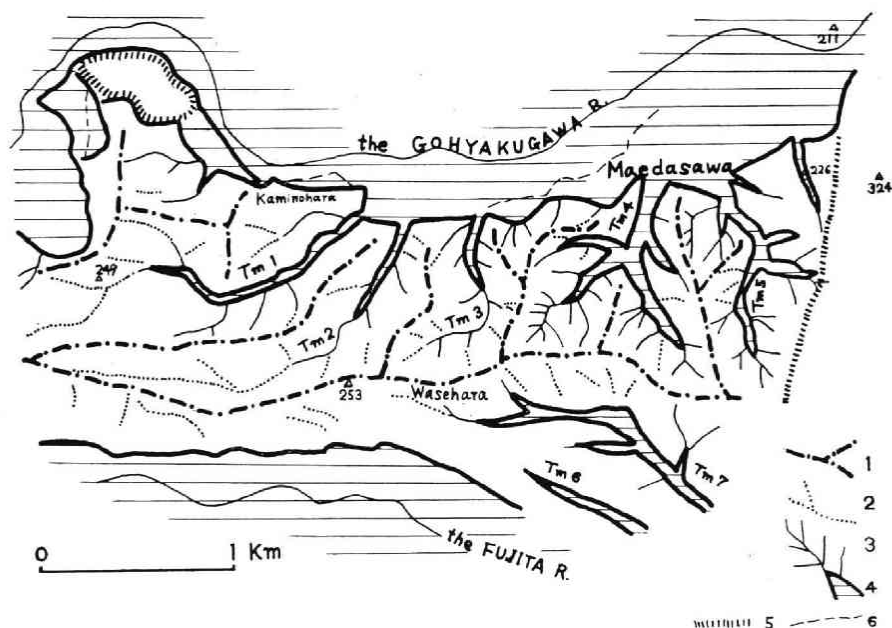


Fig. 2 The Maedasawa section 1 divide 2 Muldental 3 Kerbtal 4 Sohlen-kerbtal
5 hill foot line 6 small erosion scarp (common to Fig. 3, 4, 6, 7)

length with distances about 0.5km. In the basin of the Fujita river there are only two (Tm 6, 7) that extend parallel with the Fujita river, and others are of small scale.

As is seen in Fig. 2, *Kerbtäler* develop to the east, and to the contrary, *Muldentäler* develop densely and on a large scale to the west. Due to this contrasting distribution, the terrace is affected by transformation in such a way, that from a flat plane to an undulating surface in the west part (upstream or far apart from the terrace scarp), and a flat, continuous plane to a flat but narrow, subdivided interfluvies in the east (less apart from the terrace scarp and the lowland plain of the Gohyakugawa).

3) The Umesawa section (Fig. 3)

This area is limited by the Abukuma river to the north and the east, by the Fujita river to the south, and by the hills of basic bedrock which make a boundary against the neighboring Maedasawa section. Dissecting valleys are classified into three groups after locations of their headwaters. The one comes from the hill slope (Tu 1), another is originated in the Koriyama surface (Tu 2, 3), and the

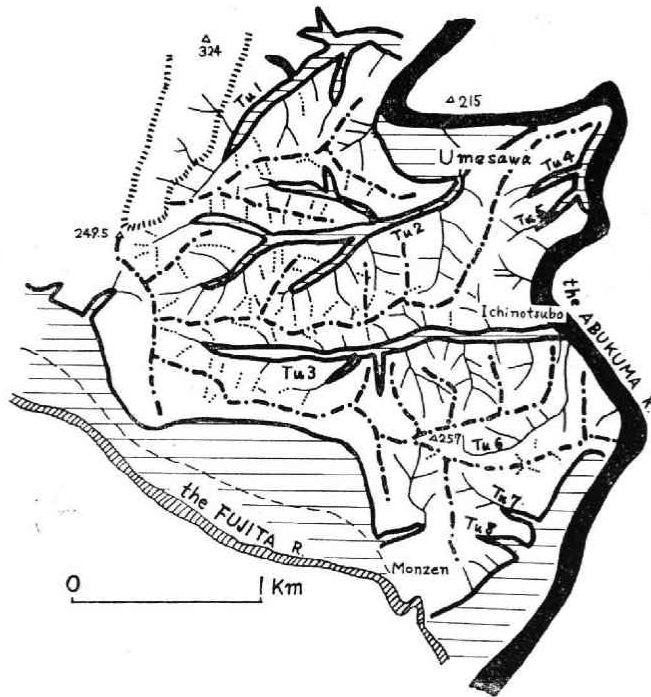


Fig. 3 The Umesawa section

third is a very small one dissecting the terrace scarps about 0.5 km long in average (Tu 4–8). *Kerbtäler* encroach deeply into the area, but in the upstream *Muldentäler* are predominant, located on rounded ridges or on flat tops even though they are very narrow. Adjacent to the Abukuma river the ridges look like knife blades and therefore *Muldenal* is scarcely preserved.

4) The Shimoyashiki section (Fig. 4)

Here, both the terrace surface and the valley plains are cultivated as rice fields, and we can easily distinguish micro-relief in an order of height difference 2–3 meters. The Fujita and the Ōse rivers flow eastward with parallel courses to make the northern and the southern fringes of the section. Terrace scarp formed by the Abukuma river sets the eastern margin, and a large tributary (Ts 1) running straight to SSE makes the western limit. Relief in this section is within 40 meters and gradient of surface is almost horizontal (0.4%). There are three main dissecting valleys (Ts 2–4) with a few branching streams, so the terrace is divided into four

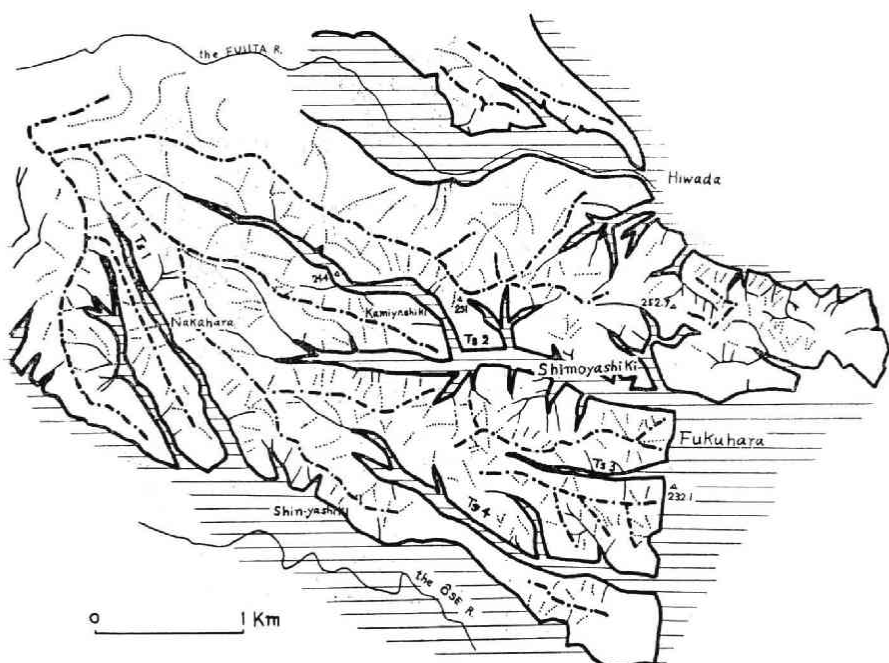


Fig. 4 The Shimoyashiki section

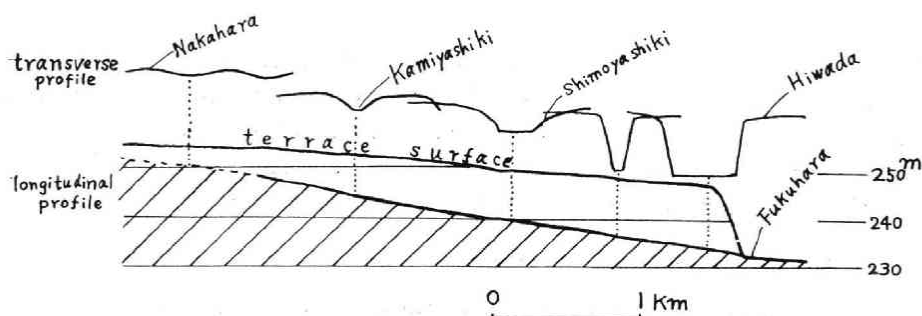


Fig. 5 Cross profiles in the Shimoyashiki section

interfluvies. The flatness of the Koriyama surface well remains in the north-eastern and the southeastern parts respectively. In spite of high density of *Kerbtal* in the eastern part, the flatness of the terrace is maintained in the form of flat, subdivided interfluvies. In the western half, *Muldental* prevails in length and

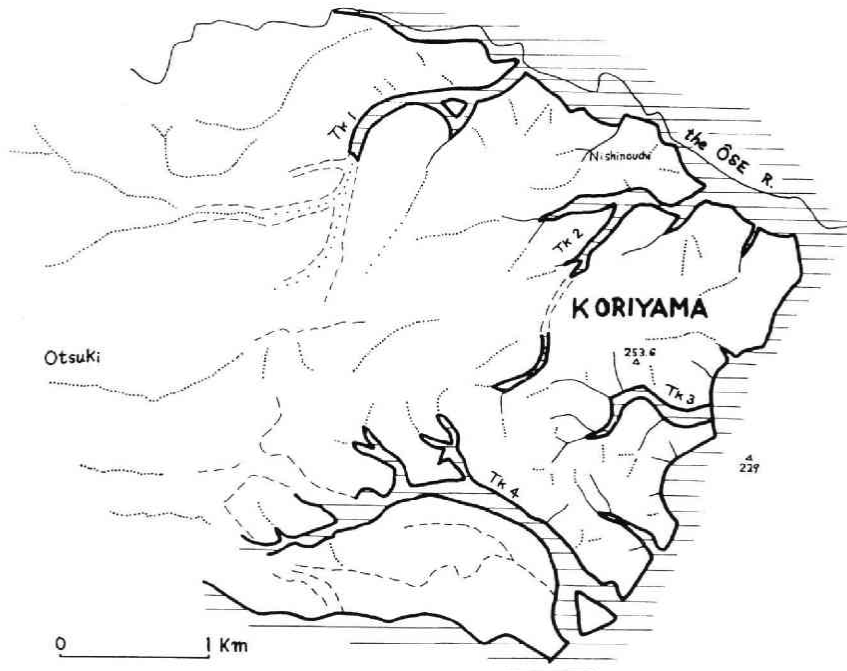


Fig. 6 The Koriyama section

density transforming the terrace surface into an undulating landform 2-3 meters in amplitude (Fig. 5).

5) The Koriyama section (Fig. 6)

This is an interfluvial area between the Ōse and the Sasakawa rivers, where the urban district of Koriyama city is located. The southern fringe is limited only by a terrace scarp, and the Sasakawa river which had once formed the scarp has shifted away southward, leaving a broad flood plain as its slip-off slope. Four valleys (Tk 1-4) dissect the Koriyama and the upper Otsuki (=the Nishinouchi) surfaces. Stream density is low as a whole, additional streams are longer than in other sections. Especially in the western part of the section, streams flow in less branched pattern at the bottom of the *Muldental*, without cutting the bed, but in the neighboring area of the terrace scarp most valleys are *Kerbtal* cutting down the terrace more than 20 meters deep. Consequently here it is examined that dissection feature is different from place to place, related to the valley form. Change in transverse form along an optional valley can be recognized clearly in the field.

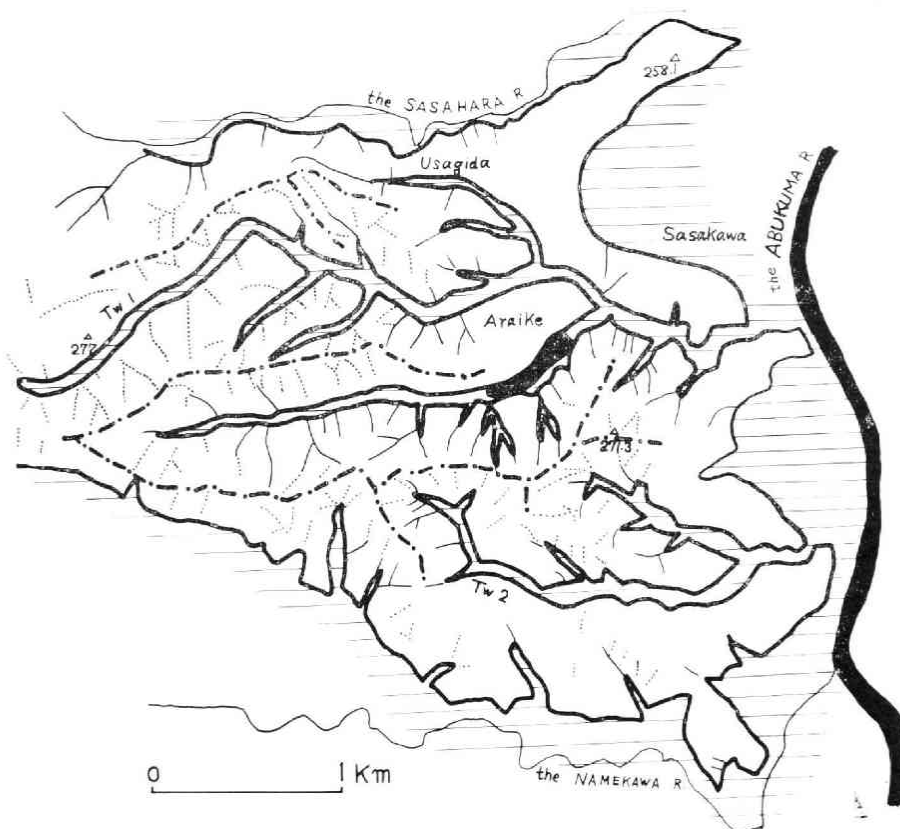


Fig. 7 The Sasakawa section



Photo 2 Head of high-level valley in the Sasagawa section (Fig. 7)

6) The Sasakawa section (Fig. 7, Photo 2, 3)

This section is between the Sasahara river to the north and the Namekawa river to the south. The western outside is covered with younger fan deposit, and



Photo 3 A small *Sohlen-kerbtal* on the terrace at Usagida (Fig. 7)

moreover, the eastern limit is bordered by an erosion scarp. The northern half of the section is the Koriyama surface, and the rest is a deposition surface of the Shirakawa dacite (Plio-Pleistocene). Relief is within 30 meters at the maximum and naturally decreases westward. Flatness of the terrace has almost diminished where *Muldental* prevails, and relatively well preserved where the terrace scarp is still fresh and steep. This means that on the finely subdivided interfluves with large relief *Muldental* has been hardly formed, and that, on the contrary, it could be formed in the upstream area with a small relief.

3. Regional variations in dissection feature concerned with different valley forms and other specific landforms

The dissected uplands above mentioned have following characteristics, judging from Figures 2–7. 1) The terrace surface is deeply dissected but remains as interfluves (regarded as feature of younger stage) near the terrace scarp. 2) The terrace surface is transformed into undulating surface with *Muldental* development at the neighboring to the divide. 3) Density of *Muldental* is higher near the divide than near the scarp (or the downstream), even when it is reduced by replacement from *Muldental* to *Kerbtal*. 4) To the contrast, *Kerbtal* develops densely near the scarp or adjacent to the main tributary.

Then it is noticeable that *Muldentäler* distribute chiefly in the upstream area, but sometimes in the downstream area in small scale adjacent to low divide. Accordingly their distribution corresponds to the network of the divides. Divide or watershed is hardly distinguishable on the flat land like terrace surface, but it must appear after rainfall. On the flat initial surface, when some low divides have been formed, supplied water would gather into a channel as running water or

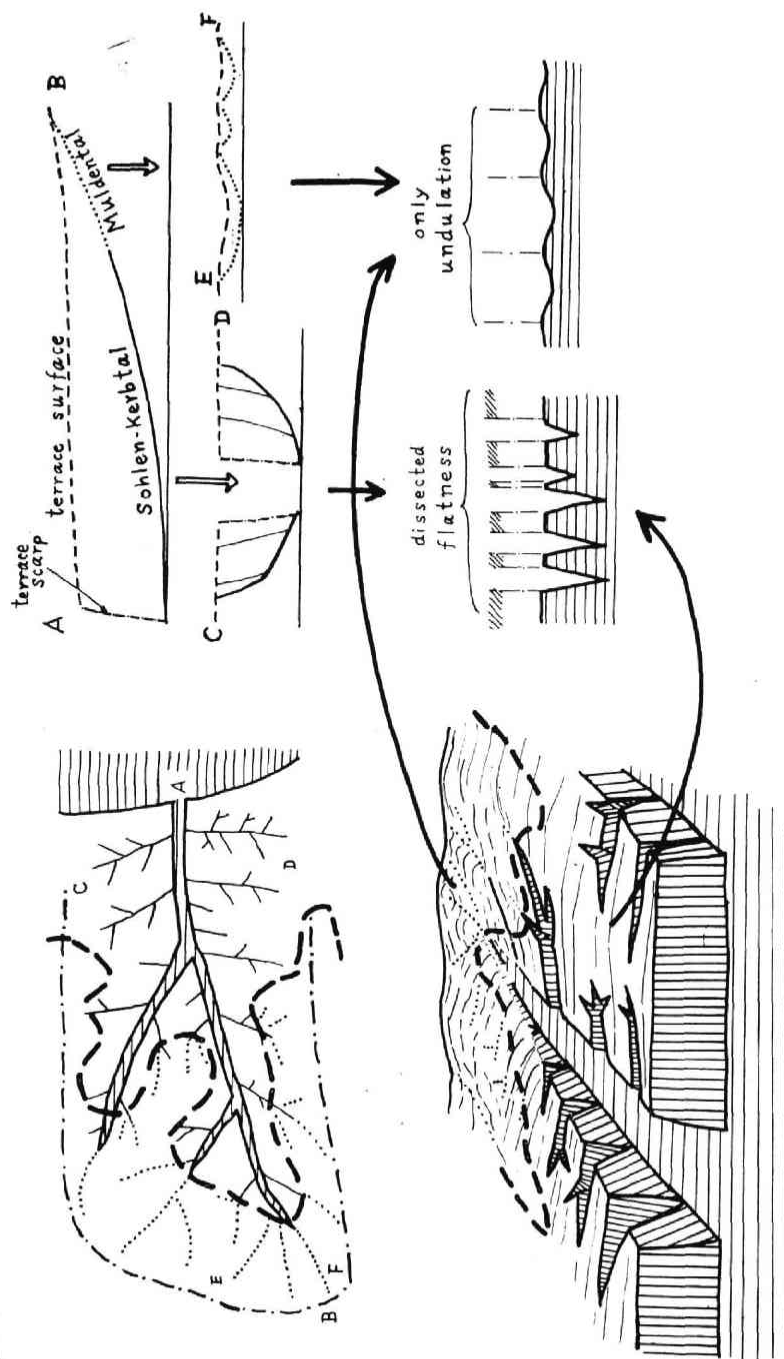


Fig. 8 A schematic diagram for terrace dissection. Broken, lines indicate the boundary between two topographical areas.

sheet flow even under minimum relief. This process is independent from quantity of uplift of the land or base level dropping, and is independent from altitude of the surface. Under this process shallow valleys (= *Muldental*) appear at first on the surface, and consequently the surface becomes undulating. When increasing water in the stream exceeds some limit, channel begins to be cut, where for the first time quantity of relief (*Reliefenergie*) rules the rate of undercutting.

Now considering about relief increase on the terrace, we find that relief can increase only by retreat of knickpoints on stream beds, and that the rate of retreat seems to be controlled by absolute volume of supplied water and of potential relief given here. So the upstream remains in long time without influence of increasing potential relief, because the area is far from the lower plain, and the area adjacent to the divide is often prevented from undercutting due to shortage of water even in the downstream area.

Presence of long *Muldental* in the upstream area (for examples shown in Fig. 4, 5, 7) means that knickpoints are situated relatively far from the divide. This is resulted from the condition that the places of these knickpoints are in much more distant from the lowland (2-3 km), and consequently they have not a sufficient relief enough to occur the undercutting of stream in spite of not a less volume of supplied water. On the other hand, many short *Muldentäler* are found in the downstream area but are limited near the branched divides. This means that on the floors of smaller tributaries knickpoints could not retreat without certain critical point for the upstream on account of large relief in addition to less volume of water.

4. Relief evolution in terrace dissection

After the Koriyama and the upper Otsuki or the Nishinouchi surfaces had been separated into the five sections by drop of the floors of the main tributaries corresponding to the lowering of base level, each section of the surface became an independent or an isolated block for erosion. Dissecting valleys could appear only under the circumstance that any place on the surface could be supplied with equal volume of water and with potential relief according to location of the place. In other words, when the Koriyama surface was subdivided into these sections, the locational condition on each section was roughly set up. There arose the upstream area and the downstream area against the lowland plain. In this stage, however, valleys can not undercut unless they obtain some relief enough to undercut. But the surface becomes more subdivided into interfluvies due to development of drainage system with *Muldental*, and comes to an undulating landform with a little relief which we see on the sections above described (Fig. 2, 4, 6, 7). To the next, streams

of *Muldentäler* start to undercut their channel beds according to the provided relief, and in this process steep scarps are produced in both sides of valleys. Thus *Muldentäler* replace *Kerbtäler*. On the branched valleys the same process is operated but more slowly. The *Muldental* developed in the branched valleys is often well preserved near the divides.

Fig. 8 indicates the writer's idea in a schematic model. Here the climatic condition, vegetation on the surface, soil forming process, etc. are not introduced. Of course they may have some important influences upon the relief evolution, for examples, intensity of runoff may be powerful under the arid climate or on surface without vegetation. However, the locational condition decides the manner of dissection (not always intensity of dissection) whether the surface makes an undulating form or a rugged feature (so-called "densely dissected" feature). This viewpoint is based on the consideration that the terrace surface is regionally differentiated in the sense of dissection pattern, that is to say, it develops into two different kinds of areas respectively. The one kind is an area represented by undulating surface where *Muldental* develops, "high-level valley" is preserved and/or in process, and sheet erosion etc.³⁾ performs to decrease a given relief. This area is "preserved" on the one hand, and is in operation of *Muldental* forming though slowly but almost uniformly on the surface, on the other hand. Another kind is an area where *Kerbtal* or *Sohlen-kerbtal* develops, undercutting, and where lateral erosion is predominant⁴⁾, and relief increases within a given potential relief. Thus the initial surface would be differentiated into the area of surface denudation and of linear erosion. Between these two areas the writer recognizes a break in slope gradient, especially apparent in hill-lands (Nakamura 1966b, 1967c, 1968). At first, the area of linear erosion progressively advanced into another area but judging from development of the drainage systems (Fig. 2-7), this advance (or retreat on the other sense) seems to cease at a limited point leaving the break in slope. It is difficult to clarify the limitation but the writer suggests that the limit line may be drawn in relation with the area of the terrain above the head-water (the point of beginning of undercutting), and with a potential relief nearby.

5. Conclusions

1) In the Koriyama Basin, the dissecting valleys on the upland (chiefly terrace of the Koriyama surface) are classified into two groups owing to their transverse profile. Those are *Muldental* type and *Kerbtal* (including *Sohlen-kerbtal*) type.

2) These different forms distribute in the drainage basins under the control

3) They are the process that is regarded as "surface denudation".

4) They are regarded as "linear erosion".

of following locational condition; *Muldental* develops a) near the divide without any relation with length of tributaries, b) consequently under less supply of water, and c) in less relief. *Kerbtal* develops not only at the downstream but also at the headwater, even where d) supplied water is enough to allow a stream undercut the channel bed, e) consequently it is situated in certain distances from the divide, and f) where relatively large potential relief is provided, instead of the volume of water.

3) The terrace surface is thus differentiated into two sections, the *Muldental* area where undulating landform is introduced in the way of surface denudation adjacent to the divides, and the *Kerbtal* area where steep slope and rugged landform are formed by linear stream erosion based on the lower base level chiefly at the marginal part of the terrace.

4) These differentiated areas go on parallel in operation of morphological process, and the boundary between them is indicated by breaks in slopes, which not always stand still at a fixed point. This system of dissection pattern seems to be observed in most regions of fluvial and coastal terraces.

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